AD NUMBER

AD840899

NEW LIMITATION CHANGE

TO

Approved for public release, distribution unlimited

FROM

Distribution authorized to U.S. Gov't. agencies and their contractors; Administrative/Operational Use; 26 JUL 1967. Other requests shall be referred to Department of the Army, Fort Detrick, MD 21701.
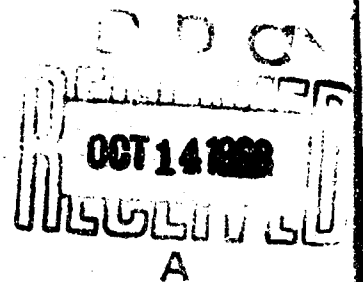
AUTHORITY

SMUFD D/A ltr, 15 Feb 1972

TRANSLATION NO. *1990*

DATE: *26 July 1967*

AD840899

OCT 14 1988

A

DEPARTMENT OF THE ARMY
Fort Detrick
Frederick, Maryland

11

IMPULSE CONVERTER FOR ADAPTING A DIFFUSED LIGHT

PARTICLE COUNTER TO A MULTIPLE CHANNEL ANALYZER *

F. J. Mönig, K. H. Rohe
and U. Pfeiffer

From the Institute for Aerobiology of the
Fraunhofer Society for the Promotion of Applied
Research, Inc., County Hochsauerland (Director Karl Bliss, M.D.)

Measuring devices are often used at present for the
measurement of aerosols which are operating according to the
diffused light process. These measuring devices have the
advantage in comparison with other aerosol measuring devices
that they make possible in the relatively short time of a
few minutes the measurement of particle-numbers and particle-
diameters within the range of about 0.3 to 30 μm.

The measuring principle has been discussed by us else-
where.** We are using the diffused light measuring equipment
202 of the Royco firm. From the optical part of this device,
a photo-multiplier is supplying electrical voltage impulses
whose amplitudes are a dimension for the diameter of the
aerosol particles that have to be measured.

** K. H. Rohe, F. J. Mönig and K. Bisa: "The
Measurement of the Retention of Various Aerosols in the
Breathing Tract With the Aid of a Diffused Light Particle
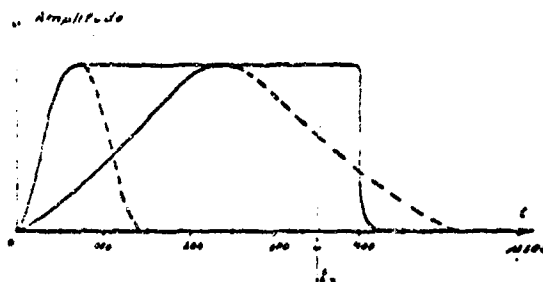Counter."

Figure 1: Principle of impulse extension at the shortest
and longest impulse of an optional amplitude.

The separating electronics of the Royco equipment
is relatively slow, however, and its scattering ability
is not sufficient for the requirements of dynamic aerosol
analyses. It is therefore preferable to use a multiple-
channel analyzer instead of Royco electronics.

Such multiple-channel analyzers have been used now
for some time in nuclear physics for the evaluation of
impulse mixtures. In contrast to Royco electronics, where
impulse separation is taking place in chronological suc-
cession in 18 channels, a multichannel analyzer is separa-
ting simultaneously in any number of channels. In about
two minutes after the beginning of the measurement, one
obtains after terminated impulse separation and storing in
the multichannel analyzer an impulse spectrum that can
immediately be made luminous on a picture tube or can be
recorded by an X-Y recorder.

However, a multichannel analyzer can process only
relatively short impulses of 5μsec duration, so that it is
not possible to transfer the ca. 200μsec lasting impulses
of the diffused-light measuring device directly to the
signal entrance of the analyzer. The task arose, therefore,
to construct an impulse converter that shortens the long
impulses emitted by the Royco equipment to 5μsec, but which
in doing so does change the value that is characteristic
for the particle size, namely the impulse amplitude.

It also had to be taken into consideration that the
impulses emitted by the diffused light analyzer can be of
varying duration at the same amplitudes. It was therefore
not possible to measure the impulse-amplitude accurately in
accordance with a definite time relay, calculated from the
beginning of the impulse. We therefore used a trick that

-2-

that is known to have been employed in similar assignments of nuclear physical measuring technique and normalized all impulses supplied by the multiplier, i.e. we extended the maximum values of all impulses to the longest impulse growth time that could be expected and also provided for a chronological safety zone. Figure 1 illustrates the principle of impulse extension at the shortest and longest impulse of an amplitude. The growth times of the impulses supplied by the multiplier amount only to about 50 to 200 μsec. After the extension of the maxima of all impulses to about 350 μsec, all impulse amplitudes can therefore be accurately measured at the point of time t_2. For this purpose it is then still required to offer the normalized impulses to a gate and to open the latter for about 5 μsec, starting at point of time t_2. The thus obtained impulse of 5 μsec duration and an amplitude that corresponds to the particle-diameter, can be offered to the multichannel analyzer for separation and storing.

The chronological cycle of the entire impulse formation, as well as a distribution among the required electronic structural components is shown in figure 2. Figure 3 reproduces the block circuit belonging to it.

The impulses of the diffused light analyzer (figure 2a), which have been produced by the photo-multiplier and have already been preamplified, are intensified to the amplitudes required for the multichannel analyzer (Nuclear Data ND-110) (figure 2b). A voltage divider at the amplifier entrance makes possible during this process the selection of six measuring ranges, which in each case differ by the factor 1.8.

Each impulse is also magnified to the limit in a separate control amplifier parallel to the linear amplifier to enable it to release with its steep front face the control electronics at point of time t_1. The point of time t_1 is determined by the impulse form and the variable amplification of the control amplifier. It can be selected in such a manner that impulses below a determined threshold value (for instance noise pulses) are not sufficiently strong for the release of the control electronics and are therefore prevented from passing the impulse converter.

-3-

Amplitude

(2a)

(2b)
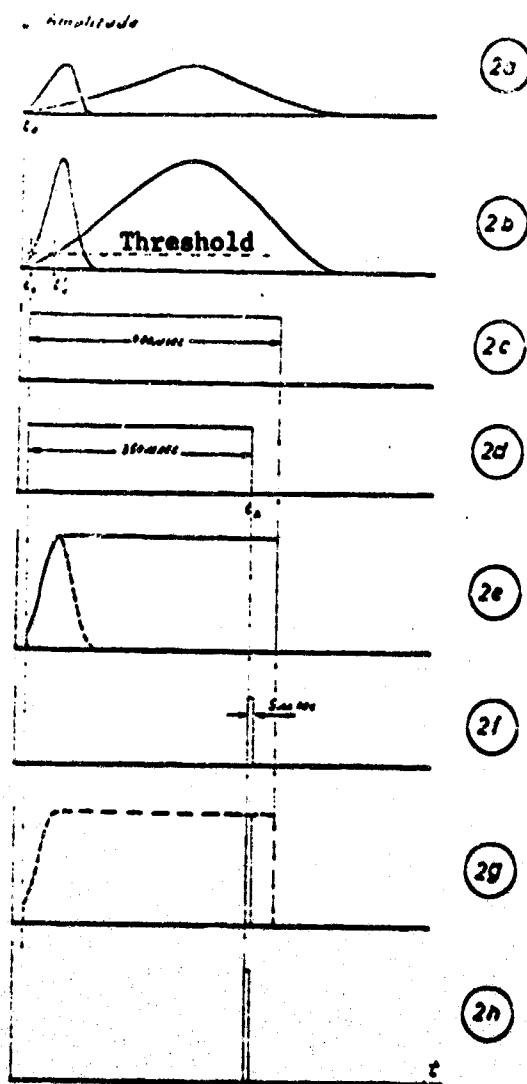
Threshold

(2c)

(2d)

(2e)

(2f)

(2g)

(2h)

t

Figure 2. Chronological cycle of the entire impulse formation, as well as a distribution among the required electronic structural components of the impulse converter (compare text).

An impulse that exceeds the prescribed threshold value, releases the two monostable sweep circuits K_1 and K_2, which differ only by dissimilar time constants, at the point of

time t_1 (figures 2c and 2d). A longer impulse of the same amplitude exceeds the threshold value at time t'_1; the release of the sweep circuits therefore takes place at a correspondingly later time. Sweep circuit 2 with the fixed time constant of 350 µ sec determines the starting time t_2 for the gate impulse; sweep circuit 1 releases from point of time t_1 for 400 µsec the impulse-elongation circuit for elongation. The impulse emitted by the linear amplifier thus obtains the form shown in figure 2e and gets closer to the gate. The gate is opened for 5 µ sec at point of time t_2 by the gate-impulse sketched in figure 2f. The gate impulse is emitted by the third monostable sweep circuit after the latter has been released by the trailing edge of the K2-impulse.

The impulse sketched by a dotted line in figure 2g can pass the gate only during the 5 µsec during which the gate-impulse keeps the gate open. The desired objective, namely an impulse of 5 µ sec duration corresponding to the amplitude of the multiplier-impulse, has thus been attained. (Figure 2h)

1) Multiple preamplifier

2) Linear amplifier

3) Impulse-elongation

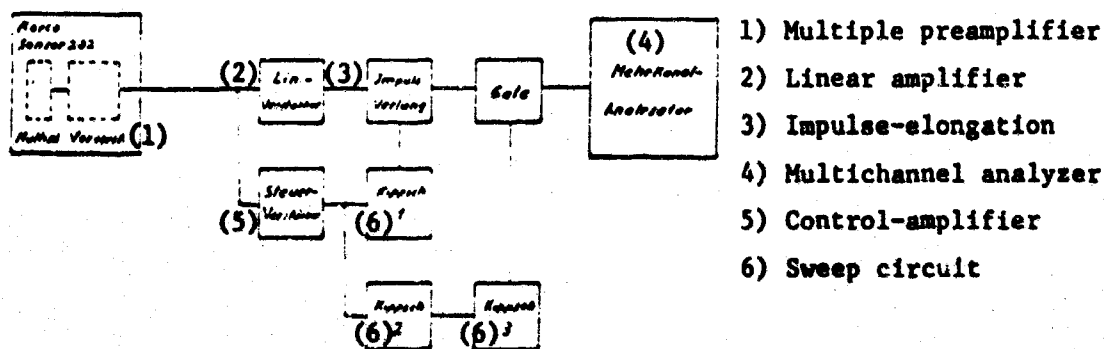4) Multichannel analyzer

5) Control-amplifier

6) Sweep circuit

Figure 3: Block circuit of the impulse converter

The Circuit of the Impulse-Converter

Figure 4 shows the circuit of the impulse-converter. For the linear amplification of the offered impulses, we

-4a-

chose a vacuum-tube amplifier. With the strongly counter-connected triode systems of tube 1 (E 182 CC), a magnification of about 30 decibels is obtained. It is followed by a cathode follower, at whose entrance all impulses are limited by a Zener diode to about 16 V. From the relatively low ohmic cathode resistance R_k of tube 2 (the first triode system of an E182CC), the impulses are arriving at the impulse-prolongation circuit, which consists of the diode 2 (AAZ15), the condenser C, and the transistor 1 (BFY50).
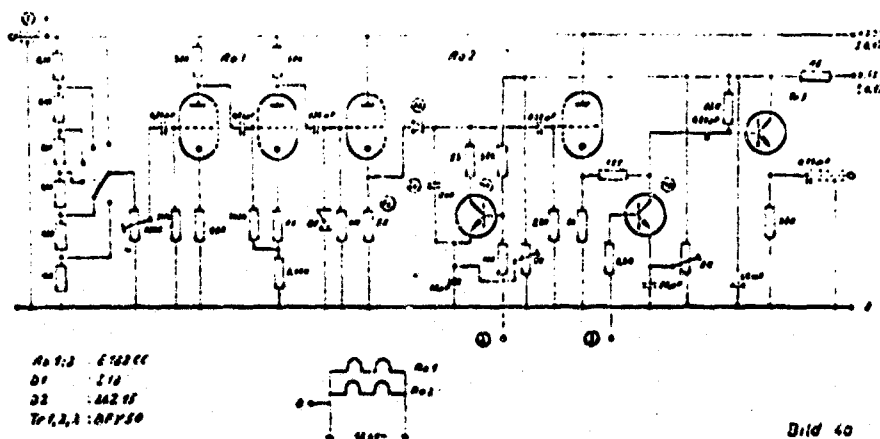

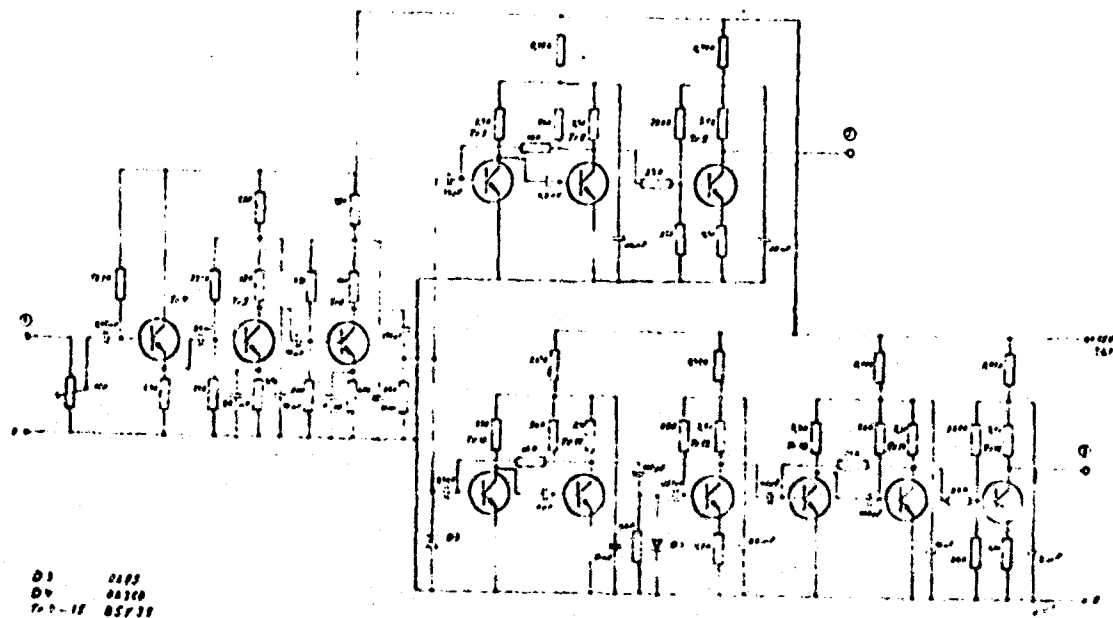Figure 4 a: Circuit of the impulse converter.

As only this part of the circuit shows important characteristics, it will be described in greater detail:

D_2 is conductive during the impulse-rise, and the voltage at condenser C follows the voltage-course at R_k. When the impulse-maximum has been reached, this maximum voltage value is retained on the condenser, for at the incipient impulse-drop at R_k, the diode is blocked. Transistor 1 works parallel to the impulse-prolongation condenser; at the arrival of a sufficiently high impulse -- as already explained -- it is blocked by the control electronics and is thus made highly-resistive. During the pulse intervals it is conductive and thus short-circuits the condenser.

The pulse prolongation functions in a satisfactory manner only if the following requirements are fulfilled, which result from the statements made above:

-5-

GRAPHIC NOT REPRODUCIBLE

Figure 4 b: Circuit of the impulse converter.

The time constant for the charging of the prolongation
condenser must be short in comparison with the shortest impulse-

-6-

rise time of about 50 sec:

$$= R_k C_v - 50 \quad \text{sec}$$

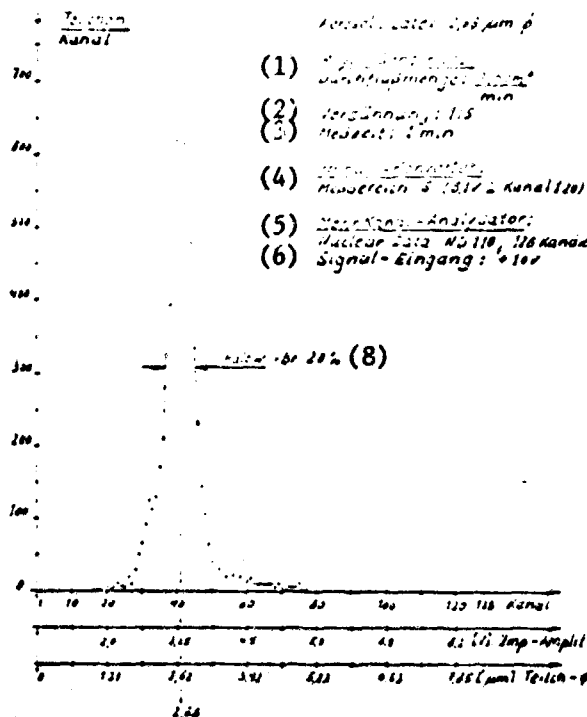In this connection the following is assumed:

The transmitting resistance of D2 is small against R_k even at the smallest impulse amplitudes; the exit resistance of Tr 1, as well as the entrance resistance of the following circuit is as great as possible against R_k.

In order to be able to keep the voltage at condenser C as constant as possible during the impulse prolongation, the reverse resistance of D2 must be large.

To avoid incorrect measurement of the impulse amplitudes, the base of C_v and Tr 1 was placed with the aid of a voltage divider on the same potential as the cathode of the charging tube.

The prolonged impulse is offered to the highly- resistive entrance of a second cathode follower (second triode system of tube 2) and then arrives from the latter's low-resistance exit to the gate. The gate consists of the conductive transistor 2 in a state of rest. The impulse therefore can only be transmitted from its collector in the desired strengthif the gate impulse appears and blocks transistor 2 for 5μ sec. The thus-obtained impulse of 5μ sec duration arrives via the low-resistance exit of transistor 2 to the signal entrance of the multichannel analyzer.

The control electronics does not contain any special characteristics. It consists of the control amplifier and three monostable sweep circuits. The sweep circuits 1 and 2 are released together by the differentiated front face of the amplified multiplier impulse, and sweep circuit 3 by the trailing edge of the X2-impulse. According to the potential-requirements, transistors (9; 12; 15) were added for potential reversal. All transistor- switch steps were provided with ample filtration in order to avoid reciprocal disturbances. The direct voltage supply of the impulse converter has been stabilized at about $\pm$ 0.1%.

-7-

Figure 5 chart with labels:

$$\frac{\text{...}}{\text{Kanal}}$$

(1) ...
$\{ \begin{smallmatrix}(2)\\(3)\end{smallmatrix} \}$ ...
(4) ...
(5) ...
(6) Signal-Eingang: ... (7)

... (8)

1) Rate of flow

2) Dilution

3) Measuring time

4) Measuring range

5) Multichannel analyzer

6) Signal entrance

·7) Channels

8) Half—width 20%

Figure 5: Spectrum of a 2.68 ,m latex-aerosol.

As example of application, figure 5 shows the spectrum
of a 2.68 latex aerosol. The impulses emitted by a Royco-
Sensor 202 were separated and stored by a multichannel
analyzer after corresponding formation in the impulse con-
verter. During the separation process, the growth of the
spectrum can be observed on a picture tube. Figure 6 is a
photograph of the spectrum shown by the picture tube. Sub-
sequently, the issuance of the measuring values took place,
which were retained by a printer as numerical values. The
spectrum was delineated in accordance with these figures.

(1)
$N = \frac{\text{...}}{\text{...}}$ (2)

1) Particle number

2) Channel

3) Channel

**Figure 6: Image-photo from the spectrum of a 2.68 μm latex-
aerosol. The same technical data as in figure 5.**

-8-

Considerable time can be saved if one connects an
X-Y recorder to the multichannel analyzer instead of the
printer. It is then possible during a measuring time of
one minute to have the completely recorded spectrum on
hand after about two additional minutes.

Figure 5 shows that the width at half maximum is
relatively large. As the standard deviation of the latex
particles, according to the statement by the manufacturer,
only amounts to 0.0149 μm, the measured large half width
is solely subject to the dissolution capacity of the Royco-
Sensor.

Because of idle time, counting losses occur in the
impulse converter and in the multichannel analyzer, but they
are equally divided among all channels, so that no influencing
of the half width is possible. In this connection it should
be mentioned that at a resonably-chosen impulse sequence
of the Royco-Sensor (about 100 cycles), the counting losses
do not exceed the value of 5 %.

A considerable enlargement of the dissolution capacity
is possible by the improvement of the diffused light measuring
device. In this respect, the impulse converter developed
by us, together with a multichannel analyzer, will be of
valuable assistance.

With the present installation it is immediately pos-
sible to obtain an insight also in the rapidly-proceeding
dynamics of aerosol processes.

Thus we have a measuring arrangement at our disposal
that offers interesting prospects for current aerosol control,
but especially for basic research.

Summary

A device has been described here, with whose aid it
is possible to offer the electrical voltage impulses emitted
by a diffused-light particle counter and obtain in this manner
within the shortest-possible time the particle spectrum of
any aerosol.